

U.S. Department of Energy  
Office of River Protection  
Engineering Case-Study - Synopsis

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HANORD BACKGROUND

One of the world's largest environmental cleanup projects is underway at the Hanford Site in Washington State. A fully integrated system of waste storage, treatment, and disposal facilities is in varying stages of design, construction, operation, or future planning. These facilities are needed to complete the U. S. Department of Energy's (DOE's) mission to protect the Columbia River, the largest river system in the Pacific Northwest. Many challenges must be met to achieve site cleanup and closure.

The 586-square mile Hanford Site is located along the Columbia River in southeastern Washington State and is home to the world's first plutonium production complex. Beginning with the Manhattan Project and throughout the Cold War, Hanford played a pivotal role in providing nuclear materials for the nation's defense programs. However, more than 40 years of plutonium production also yielded a challenging nuclear waste legacy—approximately 56 million gallons (Mgal) of radioactive and chemically hazardous wastes are stored in 177 underground tanks located on Hanford's Central Plateau. The 177 tanks include 149 older single-shell tanks (SSTs) and 28 newer double-shell tanks (DSTs).

## ENVIRONMENTAL CONTEXT

The Department of Energy is one of three signatories to the Tri-Party Agreement (also party to this agreement are the State of Washington and the Environmental Protection Agency). This framework and various regulatory regimes govern every aspect of the cleanup, and make the regulatory and permitting aspect of the work very challenging. Numerous other stakeholders are extremely involved in the multi-billion dollar effort to deal with the legacy of plutonium production at Hanford—thus the political dimension to the cleanup is significant.

## WASTE TREATMENT & IMMOBILIZATION PLANT (WTP)

The \$12 billion+ Waste Treatment & Immobilization Plant (WTP) is currently in varying stages of design, construction, and completion for the different facilities making up the most complex plant of its nature in the world. The WTP is designed to take the radioactive and chemically hazardous waste at Hanford and immobilize it in glass form for long-term storage. This plant, once fully operational, will produce tons of glass daily—it is the key to reducing the risk that the waste poses. The WTP is the final destination (at Hanford) for most of the radioactive and chemically hazardous waste in Hanford's central plateau tanks, and is thus sited in the vicinity of the 200 East tank farms—but it is six miles away from the furthest tank farm. The WTP's first operational facilities will be capable of taking a Low Activity Waste (LAW) feed as early as 2022. Additional capabilities for High Level Waste (HLW) will come on-line in later years as construction continues.

## CURRENT STATUS OF THE TANK FARM PHYSICAL PLANT & TRANSFER LINES

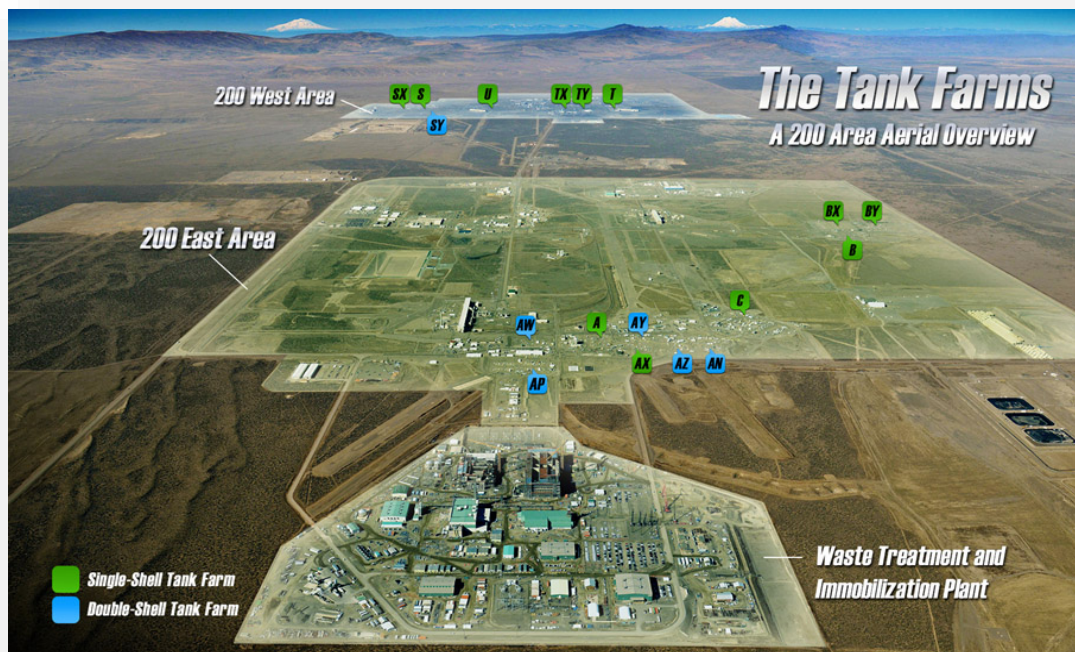
### Waste Transfer Systems

The tank farms contain underground piping so the waste can be pumped between tanks, between tank farms (there are 18 different tank farms of buried tanks—many with capacity up to 1 million gallons), to and from different facilities, and between the 200 East and 200 West Areas. The farms also contain

other equipment such as valve pits that are used to route the waste. For safety and environmental protection, the pipelines have an encased pipe-in-pipe design with sensors to monitor for leaks. Upgrades to the current waste transfer system will be required before tanks can be retrieved and waste can be delivered to the waste processing plant (WTP). These upgrades include installation or replacement of transfer pumps, installation of mixer pumps, replacement of some valves in the pits, and activation of the cross-site transfer system for moving waste approximately 6 miles to the WTP. In the future, this cross-site transfer function will play an essential role in transferring tank waste from the 200 West Area to the WTP.

#### Cross-Site Transfer Function

The need for the transfer of waste cross-site can be defined by two sub functions based on the current program analyses. The first need is to support the management of the waste located in the 200 West Area Tanks, and the management of emergency tank space which can be defined as a near term focus. The second need is the movement of waste cross-site during the retrieval and processing phase, which can be defined as a need post 2022. This need is not trivial since approximately half of the 56 million gallons of waste that is stored in underground storage tanks is in the 200 West area between 6-7 miles from the final disposition through WTP that is located in the 200 East Area (see Figure below).



The transfer of waste cross-site is necessary for the management of tank waste volumes in the 200 West Area Double Shell Tanks (DSTs). The cross-site transfer of this liquid waste will create needed space in tank 241-SY for receipt of Single Shell Tank (SST) supernatant and solids, and waste from terminal cleanout of the S-Labs. It will also allow for maintaining emergency spare capacity in the West Area in the event of a leaking tank by providing the capability to move waste out of the 200 West Area DSTs, thus providing space.

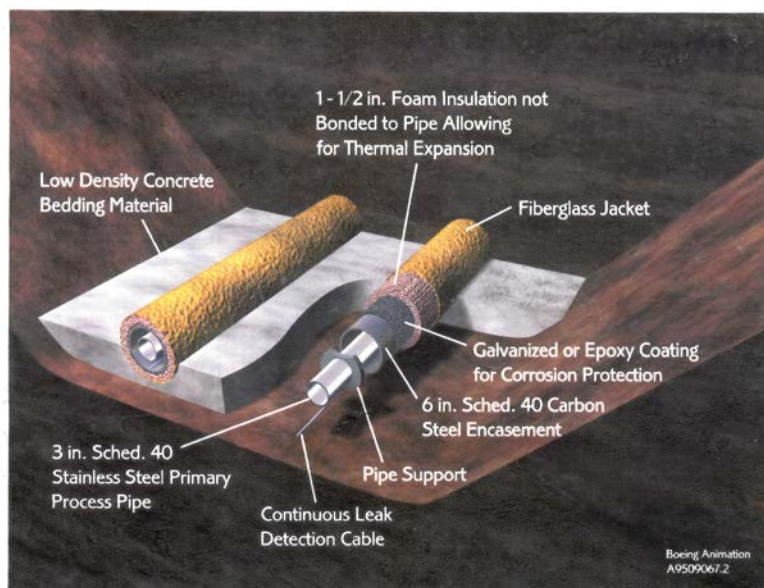
The need for tank space to, accommodate a leaking tank comes from DOE Orders that state:

*"For emergency situations involving liquid high-level waste, spare capacity with adequate heat dissipation capability shall be maintained to receive the largest volume of liquid contained in any one tank. Adequate transfer pipelines also shall be maintained in operational condition. Interconnected tank farms with adequate transfer capabilities and spare capacity may be considered as a single tank farm for purposes of this requirement."*

#### Current Capability

A capital project was designed and constructed starting in 1993 to replace six existing plugged and failed transfer lines. The replacement transfer system included functional requirements to accommodate the ability to move waste for the processing of tank waste in both the West Area and the East Area. Features in the current design included one transfer line with the ability to transfer solids by the inclusion of booster pumps designed based on the information that was available at the time.

The project known as the Replacement Cross-Site Transfer System (RCSTS) was declared operational in 1999 and was intended to transfer Single-Shell Tank (SST) waste, Double-Shell Tank (DST) waste, and other slurry wastes resulting from normal 200 West area operations to the treatment, storage, and disposal facilities in the 200 East Area. The RCSTS waste transfer system is configured in two pipes; one for liquids also known as supernates, and one pipe for solids also known as slurry. Only the supernate line has been operated. The transfer lines are a pipe-in-pipe design and are approximately 6 miles long. The primary piping is 3 inch, Grade 304L, Schedule 40, Stainless Steel pipe. The outer pipe is 6-inch carbon steel piping with an epoxy coating to minimize external corrosion. The system is designed to minimize plugging in the pipe, fittings, and other components.



The transfer system has two structures; 1) The diversion box which houses parallel booster pumps for slurry transfers and 2) The Vent station which is the high point of the system designed to promote draining of the transfer line. The transfer line has been enhanced by the addition of a more modern

control system, improved pump designs (slurry only), leak detection, HEPA filtered structures, and transfer line flushing capability.

#### Current Status of the Replacement Cross-Site Transfer System (RCSTS)

The last operations of the RCSTS was in the year 2004 and maintenance of the system has brought into question the ability to continue operations of the line. Current issues include the reliability of the leak detection system and the integrity of the piping system. In addition, the slurry line (for solids) has never been operational and recent questions on the ability to transport solids over the 6-7 miles from the 200 West area to 200 East area have been raised. Transportability is affected by non-Newtonian aspects, recent concerns for erosion and corrosion due to the waste particle density and size distribution, and plugging concerns from uncertainties in the waste including particle size distribution.

Operation of the transfer lines has become a high priority as it has become critical to be able to transport both liquids and solids to ensure adequate emergency tank space in the event of a Double Shell Tank Leak. To ensure that waste can be moved through the existing pipeline requires regulatory strategies and engineering evaluations to ensure operation of the equipment will not impact safety or the environment.

### PROBLEMS

- 1) Evaluation of the Integrity of the Existing Transfer Lines. An integrity evaluation would consider environmental conditions that the equipment has been exposed to, adequacy of the design methods used for corrosion control, remaining design life of the equipment based on the Codes and Standards, and the definition of the defensible strategy for physical evaluation of the existing transfer lines (i.e. destructible and non-destructible evaluations).
  - a. Requirement 1.a. Provide a high-level RCSTS pre-operations integrity evaluation strategy with a 95% confidence level of identifying all significance-level-1 findings.
  - b. Requirement 1.b. Identify the top-10 most significant risks to the integrity of the RCSTS system once cross-site transfers commence, and recommend risk-mitigating solutions to each of them.
- 2) Encasement Leak Detection System Evaluation. The encasement leak detection system needs to be evaluated to determine if the existing system can be utilized or replaced if unable to be repaired.
  - a. Requirement 2.a. If the system is determined to be inoperable as designed, determine if there is an adequate regulatory strategy to use the system as/is? For example the regulatory strategy would use design features such as line slope for leaks to defend the position that leaks could be detected per the requirements without an operable encasement leak detection system.
  - b. Requirement 2.b. Design a replacement encasement leak detection system that efficiently meets regulatory guidance within a set budget and construction timeframe.

- 3) **Booster Pump Design Evaluation.** Evaluation of the current booster pump design and determining if the existing pump capacities are adequate for the current and future waste constituents in the SY Tank Farms or additional capacity or pumping stations is needed. Also considerations of design life would have to be determined based on erosion considerations and pipe pressures would have to be evaluated to ensure the design loads are not violated.
- a. Requirement 3.a. Evaluate the current booster pump design to determine if it is capable of supporting waste movement as needed.
  - b. Requirement 3.b. Assess the costs, pros, cons, and optimal number of additional pumping stations (if necessary).
  - c. Requirement 3.c. Assess erosion/corrosion and its effect on pumping station component operable life.
  - d. Requirement 3.d. Assess pumping station component wear based on likely pipe pressures during operation.

### MATERIALS AND ADDITIONAL INFORMATION

Specific engineering data, schematics, applicable NQA-1 standards, and regulatory guidance will be provided to inform students and enable realistic solutions to the posed problems.

The Office of River Protection will provide an introductory presentation to frame each problem, and (upon coordination) will provide subject matter experts to personally introduce each problem.

The Office of River Protection encourages on-site tours for students to better grasp the complexities of the waste transfer challenges entailed in the cleanup effort. Tours with knowledgeable subject matter experts can be coordinated for times that best facilitate learning objectives.

The Office of River Protection will provide subject matter experts to review problem solutions (in person if coordinated ahead of time) and answer questions.

### POINTS OF CONTACT

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